ON

EPILEPSY; THE SPLEEN;

AND

THE THYROID BODY;

&c. &c.

"He that proceeds upon others' principles in his inquiry into any sciences, though he be resolved to examine them and judge of them freely, does yet at least put himself on that side, and post himself in a party which he will not quit until he be beaten out; by which the mind is insensibly engaged to make what defence it can, and so is unawares biassed. I do not say but a man should embrace some opinion when he has examined, else he examines to no purpose; but the surest and safest way is to have no opinion at all until he has examined, and that without any the least regard to the opinions or systems of other men about it. This, I own, is no easy thing to do, but I am not inquiring the easy way to opinion, but the right way to truth."—LOCKE.

18

AN INQUIRY

INTO

THE NATURE AND CAUSES

OF

EPILEPSY;

WITH

THE FUNCTION OF THE SPLEEN;

AND THE

USE OF THE THYROID BODY,

&c. &c.

By JOHN JACKSON,

MEMBER OF THE ROYAL COLLEGE OF SURGEONS, LONDON.

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PREFACE.

A KNOWLEDGE of the mechanism and purposes of the several parts of the human body has so long been regarded as an essential pre-requisite to the just comprehension of its diseases, and the sciences of Anatomy and Physiology have therefore been so long cultivated, that it appears extraordinary, that the uses of two organs of such magnitude as the Spleen and the Thyroid Body should still remain hid in obscurity. The circumstance, however, of the uses of these organs not having been ascertained, ought not to lead us to suppose that they are inscrutable; nor, indeed, does it justify the supposition that they are necessarily less obvious than those of other organs, for it sometimes happens in Physiology, as in other sciences, that the simplest truths are those which longest elude discovery.

In the following pages I have endeavoured to shew, not only that the Spleen and the Thyroid Body are, each in its own way, subservient to the most important of all functions, namely, the CIRCULATION (our knowledge of which we have long erroneously believed perfect), but also that the disordered action of the former is capable of greatly deranging that function, and thereby of influencing the cerebro-spinal system, and thus of giving rise to certain morbid phenomena, for the production of which, those who have looked exclusively to the Nervous System have failed satisfactorily to account.

JOHN JACKSON.

10, RED LION SQUARE, LONDON.
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ON

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THERE is, perhaps, no disease to which humanity is liable that has attracted a greater share of attention than Epilepsy. It is of so singular and striking a character, so obscure in its cause, and productive of such serious effects, that it has from time immemorial been the subject of speculation and inquiry. Seldom, however, have researches been less successful in their results; for of all maladies it probably is still the least understood; and, notwithstanding the great number of authors, both ancient and modern, who have written upon the subject of epilepsy, it may yet be doubted whether its nature was more a mystery in the days of Hippocrates, than it is in the nineteenth century.

It does not fall within the province of this inquiry to detail or discuss the opinions which have been already advanced regarding the proximate cause or essential nature of epilepsy; it is, however,

necessary to observe, that none which have been hitherto offered are founded on the basis of experiment, nor account either for the production of the phenomena which are observed during the seizure, or for its subsequent effects.

The great error into which nearly all inquirers seem to have fallen, is, in imagining that the appearances observed after death were the actual causes of the disease: thus we read even in the most recent works on medicine, that epilepsy may be caused by the presence of a tumour or exostosis within the cranium or spine; by cartilaginous or osseous deposits, or thickening of the membranes; by induration or softening of the white substance; or by certain changes in the pituitary or pineal glands. These opinions, however, are entirely subverted by the following facts: firstly, that such lesions are neither invariable, nor general; secondly, that they have been found in persons who have never been affected with epilepsy; and thirdly, that in those cases in which the attacks have not been followed by permanent derangement of the intellect and voluntary movements, even when the patient has died during the seizure, a state of simple engorgement of the cerebral substance, membranes, and sinuses, is all that the most careful dissection has revealed; or, if death has taken place from a casual attack of thoracic or abdominal disease, or from accident, no pathological change whatever has been detected to which the onus of causing the epilepsy could be attributed. "In this disease

(says Dr. Cheyne) we are unable to lay hold of the first link in the morbid catenation, and dissection, instead of affording assistance, rather perplexes us by the multiplicity and diversity of the changes of structure which it discloses."

If, indeed, the most carefully conducted autopsies could have revealed to us the primary and proximate causes of epilepsy, they would have been ascertained ere this. The opportunities afforded for such investigations by the Bicêtre and Salpêtrière hospitals * are immense, and accordingly, Esquirol, Bouchet, Cazauvieilh, &c., have given the details of numerous accurate dissections, which has also been done by the two distinguished German anatomists, the Wenzels; but our continental brethren, although possessing advantages, in many respects, so decidedly superior to our own, are, so far as I have been able to ascertain, just as ignorant upon the matter as ourselves. The former (the French pathologists) were of opinion that there was a great resemblance between insanity and epilepsy; that insanity depended essentially on chronic inflammation of the cineritious, and epilepsy, of the medullary substance of the brain; whereas, the latter (the Wenzels), judging from upwards of twenty elaborate dissections, attributed the production of epilepsy to disease of the sphenoid bone, pineal and pituitary glands, and affirm, that in fifteen cases out of twenty, the brain and cerebellum were unaffected.

* Parisian hospitals for the insane and epileptic.

M. Foville, the author of the article on epilepsy, in the Dictionnaire de Medicine et de Chirurgie (Paris, 1831), states, that anatomy reveals neither the essential cause nor the constant effects of the disease; and that to attempt to discover the cause which has produced the temporary insensibility and convulsions, appears to him as futile as to endeavour to trace in the brain the changes which it undergoes in directing the voluntary movements. M. Andral, in his Lectures (Lancet, No. 502,), says, that "the seat of epilepsy is clearly in the brain, although its origin may exist elsewhere;" and in reply to the question, "Does this disease leave behind it in that organ any invariable traces of its existence? that it certainly does not; and that so far we are completely ignorant of what it is that constitutes the essential pathological character of epilepsy."

Epilepsy is derived from the Greek verb, ἐπιλαμβανω, *I seize*, and has received a great variety of names, mostly indicative of its supposed supernatural origin;* such are, Morbus Sacer, M. Herculeus, M. Demoniacus, &c. It is rather a common affection, and occurs with nearly equal frequency in both sexes. It is most common in early life, least so in

* "L'epilepsie (says M. Foville) a été observée dès la plus haute antiquité. Dans les temps d'ignorance et de superstition, sa forme effrayante, son invasion subite, l'ont fait considerée comme infligée par les courroux des dieux. À Rome les assembleés du forum étaient dissoutes quand un epileptique tombait. La science est aujourd'hui debarrassée de toutes ces superstitions; mais elle n'est pas encore bien avancée dans la connaissance de cette maladie."

advanced age. From the circumstance of children being so frequently attacked by this disease, it has been termed by the French, 'Mal des enfans.'

The following table, shewing the comparative frequency of epilepsy, at different ages, among the females at the Salpêtrière, is extracted from Andral's Lectures, published in the Lancet (No. 502).

				Cases.	
Ages from	1	to	5	18	nine congenital.
	5		10	12	
	10		15	11	
	15		20	10	
	20		25	4	
	25		30	4	
	30		35	1	
	35		40	2	
	40		45	1	
	45		50	2	
	50		55	0	
	55		60	1	
				66	

Thirty-eight were previous to the commencement of the catamenia, and twenty-eight afterwards.

Epilepsy has been divided, since the days of Hippocrates, into idiopathic, in which the cause of the disease is supposed to exist in the brain (pure, or cerebral epilepsy), and sympathetic, in which the cause is supposed to be an *irritation* in some other organ, or part, affecting the brain by *sympathy*. The following have been mentioned by authors as sympathetic epilepsies:—spinal, pulmonary, cardiac, hepatic, stomachic, nervous, or atonic, nervous from

irritation in the course of a nerve, uterine, genital; —also traumatic, inflammatory, rheumatic, metastatic, arthritic, intermittent, cancerous, scrofulous, ricketty, syphilitic, and complicated ! The existence of sympathetic epilepsy was first denied by C. Lepois, who remarks, that it is illogical to attribute an affection of the head to other parts or organs in which there is no appreciable alteration of texture. M. Georget (Dict. des Sciences Med.) expresses a similar opinion, and states that he has never witnessed epilepsy produced by sympathetic influence, although he does not deny the possibility of such occurrence.

The causes of epilepsy have been usually treated of under the three heads of predisposing, exciting, and proximate or essential. The proximate or essential cause is the pathological state which gives rise to the symptoms, or upon which they are immediately dependent; but this pathological state cannot produce itself; the proximate cause is therefore an effect, and it is the cause of this effect which is to be regarded as the primary cause, or *cause par excellence*, in the production of epilepsy.

There is perhaps, strictly speaking, only one predisposing cause, namely, hereditary predisposition. According to Calmeil, out of 130 epileptics, 99 were descended from healthy parents, and 31 from parents affected either with insanity, epilepsy, mental imbecility, or hysteria. This agrees with the observations of MM. Bouchet and Cazauvieilh, who state, that out of 110 epileptics, 31 were hereditary.

The former observes, that 14 epileptic females had together 58 children, 32 of whom died young and in convulsions; of 26 who lived longer, 14 had neither epilepsy nor any other nervous malady, 7 had various nervous diseases without convulsions, 2 only were epileptic, 2 had simple convulsions, and 1 was hysterical. M. Georget mentions an extraordinary example of the hereditary influence; he states that an epileptic father had eight children, all epileptic, of which number seven died in early life (en bas âge), and the eighth in his eighteenth year.*

Cranial conformation is considered by some writers as a predisposing cause. Epilepsy is frequently, but by no means generally, observed in persons with a low, contracted, and receding forehead, more or less approaching the idiotic; but this peculiarity of the shape of the cranium is owing to arrested growth or imperfect development of the cerebrum, and ought, perhaps, to be regarded rather as an effect than as a predisposing cause of the malady.

That epilepsy is not essentially dependent on, nor necessarily connected with, defective organization, or disease of the cerebrum, producing idiocy, mental imbecility, or insanity, is proved by the fact, that some of the greatest men of ancient and modern times, men alike eminent both for talent and acquirements, have been subject to occasional attacks of this disease.

* It has been stated, but I do not know with what degree of truth, that when epilepsy is hereditary, it is most frequently derived from the father, and hereditary insanity from the mother.

A great number of exciting causes have been mentioned by different authors. The sympathetic epilepsies are merely technical expositions of some of the supposed exciting causes. Dr. Elliotson states, in his Lectures, that "the disease may arise from every sort of irritation in every part of the body." It would indeed be difficult to say to what it has *not* been attributed; for example, M. Andral (Lancet, No. 502) is represented to have said, that "a great majority of cases are known to occur by night, and it would be difficult to decide, whether sleep, or the absence of the sun from the hemisphere, was the actual cause; both, perhaps, contribute to the effect produced!"

The following are considered as the principal exciting causes:—

1. Sudden fear or fright.
2. Inordinate mental emotion; as, anger, grief, anxiety, disappointment, &c.
3. Excessive venery, and masturbation.
4. Suppression of accustomed evacuations, especially the hæmorrhoidal; repelled cutaneous eruptions.
5. Eruptive period of certain exanthematous affections; as, small-pox, measles, scarlet fever.
6. Plethora, or anæmia; excessive blood-letting; hypercatharsis; worms.

Tissot, Esquirol, Georget, and J. Frank, indeed all the best authorities upon the disease, both British and foreign, agree in regarding *Fear* as the most

frequent and important of the exciting causes of epilepsy. M. Georget states (Dict. des Sciences Med.), that fear *produces* the disease in the majority of cases; M. Tissot, that it *renews* the paroxysm most frequently; and J. Frank affirms that out of eighty cases which came under his observation, the disease in sixty had been brought on by fear.

It would be premature in this early stage of the inquiry to treat of the proximate cause or pathological state which gives rise to the symptoms; or of the primary cause. I shall therefore proceed to mention the phenomena which sometimes precede the paroxysm.

The paroxysm is occasionally preceded by certain precursory or admonitory symptoms, sometimes observable by the friends or persons immediately about the patient, and sometimes by the patient himself. These premonitory symptoms are by no means frequent, but M. Georget must, I think, be in error, when he says that they do not occur in more than five or six instances out of a hundred.

The patient may evince certain changes in his disposition, or an oddity in his manner; he may hesitate in his speech, or appear confused; he may be capricious, or morose, or unusually irascible; he may complain of giddiness, of indescribable sensations, or 'curious feels,' of a feeling of fulness, or emptiness of the head; there may be alternate paleness and flushing of countenance, and very commonly a slight swelling of the hands and lividity of the ends of the fingers may be observed; he may

have also various illusions of the senses, that is, he may hear an extraordinary noise, see luminous objects, smell disagreeable odours, or have a singular taste in the mouth, &c.; or lastly, he may feel an acute pain, or have a sensation of numbness, or of warmth, or heat, or cold, or chilliness, or creeping in some part or other; this has been termed the *aura epileptica*, but it, like the others, is merely a false or illusory sensation, and does not occur in the great majority of instances.

These sensations, which the French call "prodrômes" (warnings), may cease and recur at intervals, or precede the fully developed paroxysm. The peculiar giddiness or momentary state of half consciousness, to which epileptics are so liable, is indeed an imperfect seizure, and differs only in degree and duration from the state called catalepsy; it is termed by the French 'vertige epileptique' or 'petit mal,' in contradistinction to the perfect seizure, or 'grand mal.'

The epileptic paroxysm, or perfect seizure, equally sudden in its invasion whether preceded or not by any of the foregoing symptoms, is ushered in by a loud and peculiar cry or scream, and the patient falls senseless to the ground. This state of insensibility continues throughout the paroxysm, and is so complete that the most powerful impressions or stimulants, as pungent odours, pinching, burning, &c., fail to produce the least sign of consciousness. After a brief period of muscular quiescence, or relaxation, there is next observed a state of tetanic

rigidity of the neck, trunk, and limbs, which is also usually of short duration, being quickly succeeded by powerful convulsions of the whole muscular system; occasionally, however, one side of the body is more convulsed than the opposite. The eyes roll, or are fixed, and there is an unnatural, and sometimes hideous, strabismus; the pupils may be either dilated or contracted, but are motionless. The mouth is drawn to one side, and there is gnashing and grating of the teeth, by which the tongue is often bitten, and the teeth broken.* The distortion of the features is ever varying, according to the alternate contraction and relaxation of the different facial muscles. The upper extremities are usually more convulsed than the lower; and the hands are clenched and the thumbs flexed and thrust into the palms. There is also foaming at the mouth, the face, the neck, and hands become swollen, the jugular veins are excessively distended, and the countenance, more especially the lips, and also the fingers, are violaceous or livid. The respiratory function is very imperfectly performed, or is altogether arrested, the patient as it were holding his breath, and as Dr. Reid observes, "if the abdomen be forcibly compressed, a very peculiar flapping of the diaphragm is felt," which indicates that this muscle is equally convulsed with the rest of the muscular system. There is also intermission, or greatly en-

* Van Swieten relates an instance in which the lower jaw was dislocated in a violent epileptic attack.

feebled action, and irregularity of the pulse.* In addition to these symptoms there is often expulsion of the urine and fæces, and sometimes emissio seminis. Such are the ordinary symptoms of an epileptic paroxysm, which may endure less than a minute, or may be prolonged to five or six minutes. The mean duration, according to Georget, is from two to three minutes. The muscles then relax, and the convulsive movements are at an end; the lividity and turgescence vanish, and are succeeded by paleness; the patient draws a deep sigh, breaks out into a sweat, is still unconscious, motionless, and appears in a kind of lethargic sleep, or sopor, which may last from five minutes to half an hour. He then regains the power of voluntary motion, and consciousness, but has no recollection of what has passed during the paroxysm.

For an indefinite period subsequently, the patient appears drowsy, is averse to moving about, answers questions in a confused manner, feels fatigued, and complains of more or less pain in the head and limbs; and is perhaps affected with nausea or vomiting. In some instances, when the paroxysm has been very violent, or there has been a succession of paroxysms with short intervals, a partial and tem-

* "It will be found on careful attention, that the first symptom of an attack is the suspension of the action of the heart, and consequently an intermission of the pulse, which may continue from a few seconds to about three minutes, which was the longest period of intermission I have as yet known."—On the Pathology of Epilepsy, by Dr. Reid, p. 361, Vol. iv., of the Transactions of the King and Queen's College of Physicians, in Ireland.

porary paralysis, some degree of mental aberration, or even mania, supervenes.

Death, during the paroxysm, is not of infrequent occurrence, especially amongst children; when this takes place, the intervals between the respiratory acts are extremely prolonged.

The symptoms of an epileptic paroxysm bear a close resemblance to those observed in asphyxia from suspension. When a criminal is executed, or an animal is hung, the following phenomena are produced :—unconsciousness—convulsions, chiefly of the face and upper extremities—turgescence and lividity of countenance—relaxation of sphincters—seminal emission—and death. Precisely the same group of symptoms, therefore, as occur in a fatal epileptic paroxysm. But suppose that a person attempts suicide by suspension, and is only *half* hung, —that he is cut down before life is extinct, and recovers,—the analogy still holds; he has no recollection of having suffered during the suspension. The following quotation is from Dr. Elliotson's Lectures: "Although the individual may struggle, and although he may be all but dead, and may hang so long as to be insensible, it does not appear that there is any suffering. There is an account in Lord Bacon's Works, of a person who was hung and all but killed, and yet he did not suffer. There is a short account written by * * *, the poet, from which it appears that he three times attempted to commit suicide, and one of these attempts was by suspension. He there mentions that he suspended

himself over his chamber door in the Temple, and became insensible. He only recollected a flash of light appearing before his eyes. His weight at last caused him to drop on the floor, where he was found, and after a short time he recovered. He says that although he was thus in the jaws of death, and had become perfectly insensible, yet he had no previous suffering."

Observing the analogy between asphyxia from suspension (which I suppose does not differ from the other asphyxiæ except in the mode of its production) and the epileptic paroxysm, that they are attended by a similar train of phenomena or symptoms, I was led to suspect that the pathological state which gives rise to them might be the same in both instances; and which state I conceived (although erroneously) to be that of simple cerebral congestion, outward evidence of the existence of which, during, but more particularly towards the termination of the epileptic paroxysm, is afforded by the lividity and turgescence of the face and hands. I determined, therefore, to ascertain by experiments the real value of simple, yet perfect, cerebral congestion; and to learn whether it is merely a symptom and an effect, or whether it is at all concerned in the production of insensibility and convulsions. Having found that tying the jugular veins on both sides of the neck of a living animal is insufficient, because of the vertebral veins, to produce perfect cerebral congestion, I resolved to place a ligature upon the superior cava, and, with this intention, I

availed myself of the able assistance of Mr. Spooner of the Veterinary College.

Exp. 1. An incision was made through the cartilages of two ribs on the right side of a dog, immediately behind the scapula, the anterior extremities being drawn forward by an assistant; the integuments, intercostal muscles, and pleura costalis, connecting them with the adjacent ribs, anteriorly and posteriorly, were then divided to a considerable extent in the direction of the spine, and thus a large opening was made into the cavity of the chest: the hæmorrhage was not very considerable, the intercostal vessels only having been divided, and a ligature was quickly, and with but little difficulty, applied upon the superior cava above the vena azygos, which in dogs terminates in that vessel just as it is about to enter the auricle. The two ribs were then replaced, and the wound closed by sutures. Upon the application of the ligature there rapidly ensued great lividity and turgescence of the tongue and mucous lining of the mouth, which was attended by perfect insensibility, as was proved by pricking the nose and feet, but no convulsions occurred. After the lapse of a few minutes, the turgidity and lividity of the tongue and mucous membrane had diminished, although it was still considerable. The cords by which he was fastened were then removed, and to the astonishment of all present he got upon his legs, shook himself, and, without much apparent difficulty, walked to the other end of the room, where he lay down. After the cava had been tied a full

quarter of an hour, he was evidently much less insensible, and appeared, indeed, to be gradually recovering from the immediate effects of the operation. I even began to suspect that the ligature had become loosened; and, as the object in view was not to ascertain how long a dog could live after having a ligature placed on the superior cava, but what immediate consequences would result from simple yet perfect cerebral congestion, about a drachm of hydrocyanic acid was administered, which was speedily fatal; and, on re-opening the chest, I satisfied myself that the ligature still remained perfect.

The result of this experiment, although only in part what I had anticipated, was important, inasmuch as it proved that cerebral congestion is productive of insensibility, but not of convulsions. As the turgidity and lividity of the tongue and mucous membrane, and also the insensibility, had become less shortly after the operation than they were immediately after it, I inferred that the cerebral congestion had also diminished, which I accounted for by the communications of the lateral sinuses and jugular veins with the vertebral veins, of the vertebral veins with the vertebral sinuses, and of the latter with the intercostal veins, branches of the *vena azygos;* and that by these venous anastomoses, the blood from the distended cerebral sinuses found its way through the medium of the vena azygos into the auricle.

As *insensibility* was the consequence of *cerebral* congestion, it occurred to me that *convulsions* might

probably be produced by *spinal* congestion; and therefore I determined, in the next experiment, to tie the vena azygos as well as the superior cava. It is here necessary to remind the reader of a fact the importance of which has not been duly appreciated, namely, that all the blood from the vertebral sinuses enters the right auricle by the superior cava, with the following trifling exception:—the blood which is supplied to the cauda equina and lower part of the spinal membranes by the two inferior lumbar arteries, and the arteriæ sacræ laterales, is returned by corresponding veins to the inferior cava; but even the inferior lumbar veins communicate with the superior lumbar, and the latter with the radicles of the vena azygos. The vena azygos usually communicates on the right side with the inferior cava, and on the left side with the renal vein, and returns at least three-fourths of the blood from the vertebral sinuses; and, with the exception just pointed out, the remainder enters the subclavians by the two vertebral veins.

Exp. 2. On the following day, the chest of a dog was opened in the same manner as in the preceding experiment, and one ligature placed around the vena azygos, and another under the superior cava, the latter being tied directly after the former. Insensibility the most complete, accompanied by strong tetanic convulsions of the whole muscular system, immediately ensued; and there was also, as in the first experiment, great lividity and turgescence of the mucous membrane of the tongue, lips, and

mouth; and these symptoms (the insensibility and convulsions, as well as the lividity and turgescence) continued until the animal's death, which quickly followed; but not until after we had closed, by two or three sutures through the integuments, the opening which had been made into the cavity of the chest.

Exp. 3. The last experiment was repeated, but with no observable difference in the effects which were produced.

The three preceding experiments, it is thought, will justify the following inferences :—

1. That cerebral congestion gives rise to insensibility, and spinal congestion to convulsions.*

2. As the presence of cerebro-spinal congestion in the epileptic paroxysm is denoted by the lividity and turgescence of the face and hands; and as insensibility and convulsions are the two essential symptoms of the paroxysm,—that cerebro-spinal congestion is the pathological state or proximate cause which gives rise to those symptoms.

3. That the primary cause, the cause *par excellence*, or primum mobile of the epileptic seizure, is necessarily a *something* which is capable of rapidly inducing cerebro-spinal congestion.

In the second proposition it is stated, that livi-

* It must be borne in mind that the anterior columns of the spinal cord are the motor columns, and that the vertebral sinuses are in front of the theca vertebralis; and, also, that each spinal nerve in passing through the corresponding intervertebral foramen is closely embraced by a plexus of veins.

dity and turgescence of the face and hands are evidences of the existence of cerebro-spinal congestion during the paroxysm; they are, however, usually regarded as signs merely of cerebral congestion, and as they are not observed at the commencement of the paroxysm, and are most marked just before it terminates, it has been inferred that congestion (by which cerebral congestion only is meant) cannot be the cause of the symptoms, namely, insensibility and convulsions, inasmuch as these symptoms commence before it is supposed the congestion is produced. But, in the first place, it is incorrect to regard lividity and turgescence as indications of cerebral congestion *only;* it being manifest, that whatever the cause may be which prevents in the epileptic paroxysm the return of blood from the head and arms, must also necessarily prevent its return from the spinal cord; in other words, that if the venous current in the subclavian, jugular, and vertebral veins, and cerebral sinuses, be arrested, it must also be arrested in the vena azygos and vertebral sinuses: and, secondly, it is erroneous to suppose that the congestion does not commence before its existence is denoted by the outward signs of lividity and turgescence, because the former can be almost instantaneously produced, whereas the latter require a certain time for their development.

To cerebro-spinal congestion, therefore, is assigned the production of the symptoms; it is consequently to be regarded as the *proximate* cause. The next question is: What is it which in epilepsy can give

rise to cerebro-spinal congestion? or what is the nature of the *primary* cause?—It has already been observed that in epilepsy the seizure is sudden, and that it is commonly of only two or three minutes' duration; the congestion therefore, to arrive at its height and to terminate in so short a space of time, *must* be dependent upon some cause preventing during that brief period the return of the venous blood from the brain and spinal cord simultaneously. Now what is there that is capable of producing this effect? It cannot be any thing *above* the opening of the vena azygos into the superior cava, or the congestion would be merely cerebral, and not cerebro-spinal; it must therefore be *below*.

It is evident that the superior cava cannot oppose the return of blood from the brain and spinal cord; we must therefore descend to the right auricle; and here we find no malformation, no change of structure, nor indeed any physical cause capable of arresting the current which enters it by the superior cava. But in epilepsy this arrest *does* take place, and consequently some cause, near or remote, must prevent ingress by that venous trunk into the auricle; for, if the blood have free and constant admission from the former into the latter, there can obviously be no cerebro-spinal congestion.

There are, I conceive, at least two ways in which the ingress of blood into the auricle from the superior cava may be suddenly prevented, and cerebro-spinal congestion consequently induced. Firstly, blood being returned to the heart of a *quality* more

or less incapable of stimulating its right cavities, and which the ventricle therefore refuses to propel or very imperfectly propels, through the lungs; the immediate effect of which necessarily is, that distension more or less excessive of the right cavities is produced, and the further ingress of blood from both venæ cavæ either greatly impeded, or altogether denied: and secondly, the *quantity* of blood supplied to, and the force with which it enters the auricle by the *inferior* auricular opening, being suddenly and temporarily augmented by a force greater than that with which the blood descends into that cavity from the superior cava; and which sudden and temporary augmentation can only be effected by an inordinate rush of blood from the hepatic veins: then, in this case as in the former, the right cavities, but more especially the auricle, would suffer undue distension, ingress by the superior cava would be prevented, and cerebro-spinal congestion would ensue, and endure so long as the rush into the auricle from the hepatic veins continued. But what is there to cause an inordinate rush of blood into the auricle from the hepatic veins? In order to answer this question it will be necessary to consider, first the vessels themselves; and secondly, to ascertain the nature of that *power* by which the blood is propelled through them to the inferior cava and auricle.

The hepatic veins consist of two or three large veins, called from their size venæ *cavæ* hepaticæ,*

* There are two injected preparations in the Museum of the Royal College of Surgeons, Nos. 18 and 19 of Part vi., which

which open into the inferior cava, just before it penetrates the diaphragm, and six or seven smaller ones, which open into that vessel before the terminations of the larger veins. These veins return the blood from the liver, and not being surrounded by a loose cellular envelope like the trunk and branches of the portal vein, but firmly connected with the substance of the organ, they are simple canals, always of the same calibre, and therefore must always contain the same quantity of blood.

The radicles of the hepatic veins commence in the centre of each lobule, and communicate with the portal plexuses, but not with the minute branches of the hepatic artery, nor the biliary ducts; and, as the hepatic veins are mere canals and destitute of valves, it is impossible for them to act upon their venous contents in any way; they have neither the power to oppose nor to assist, and as they communicate with only one set of vessels in the liver, the minute divisions or plexuses of the portal vein, it is to this vessel necessarily that we must look for the power which propels the blood through the hepatics.

The roots, trunk, and branches of the portal vein are also destitute of valves, but this vessel differs from the hepatic veins by being surrounded, from the commencement of the trunk to the terminations of the branches in the portal plexuses, by a loose cellular tissue, which accompanies it from, and is a prolongation of, Glisson's capsule; and by this

give a correct idea of the *relative* magnitude of the hepatic veins, and the superior and inferior venæ cavæ.

peculiarity the portal trunk and branches are especially adapted to contain more or less blood; as it allows either of their distension or collapse in proportion to the varying quantity of their contents. It is, however, evident, that each of the three divisions of the portal vein is as incapable as the hepatic veins of rendering any active assistance in the propulsion of the venous blood.

The portal vein conveys to the liver the venous blood from the spleen, pancreas, gall-bladder, stomach, and intestines; and which organs are supplied with arterial blood by the cæliac axis, and the superior and inferior mesenteric arteries. We have next, therefore, to turn our attention to these arteries; to consider the size of their trunks and principal branches; the large size and flexuosity of the splenic—the small size of the hepatic—and the arched or tortuous course of those distributed to the stomach and intestines; the frequent divisions, subdivisions, and anastomoses of the latter before they terminate in the extensive capillary network between the mucous and muscular coats; and then we have to inquire: Is the vis à tergo of the heart's action through the cæliac and mesenteric arteries and their several branches, an *adequate* power, not only to propel the blood through their capillary terminations* and the corresponding veins to the

* The capillaries of the splenic artery terminate in the venous plexus of the spleen; those of the hepatic, as Mr. Kiernann has demonstrated, not in the radicles of the hepatic veins, but in the plexuses of the portal vein.

point where they unite to form the portal trunk; but also, through the trunk of the portal vein, through its divisions and subdivisions in the liver, through another extensive capillary system, the portal plexuses; and then through the radicles, branches, and trunks of the hepatic veins, to the inferior cava and auricle? and this (in the erect posture at least), in direct opposition to the influence of gravitation, and without the assistance of valves? Müller (see Baly's Trans. p. 234) says, that "in all the vertebrate animals, the vis à tergo of the heart's action *is* sufficient to propel the blood through the liver after it has already circulated through the capillaries of the other abdominal viscera:" and this, indeed, is the opinion which has been held unquestioned since the discovery of the circulation; but, notwithstanding its antiquity, it is (as further examination will demonstrate) both unsupported by probability, and unfounded in truth.*

As we do not observe in any other part of the economy the vis à tergo of one set of arteries propelling the blood through two venous and two capillary systems, we might (if so strange an anomaly did really occur) expect to find the cæliac and

* "The capillary circulation, that is to say, the passage of the blood through the capillary vessels, is of all the parts of the circulation that which, without being independent of the action of the heart, is yet less subjected to it. It is the point of the circulation at which the motion of the blood is the slowest; and at which the blood, divided into minute threads, has the most points of contact with the walls of the vessels."—Béclard, Trans. by Dr. Knox, p. 177.

mesenteric arteries and their branches so disposed, that the blood in passing through them should meet with the least possible resistance, and thus any great diminution or expenditure of the vis à tergo be prevented. But does any such favourable disposition of these vessels exist? On the contrary, their numerous flexuosities and anastomoses render them of all vessels (with the exception, perhaps, of those supplying the brain) the most calculated to retard and impede the arterial current. Again, after the blood has been propelled through the first capillary system into the radicles of the portal vein, instead of its ascent through the three divisions of that vein being *more* facilitated and assisted than any other ascending venous current, which (as the portal blood has to overcome the resistance offered by a second capillary system, the portal plexuses) we might reasonably suppose would be the case, we find that it is *less* so; for its ascent is not favoured, as in other parts, by muscular contraction, nor is its descent prevented by valves.

If we consider the arteries of the lower extremities, and contrast them with those supplying the stomach and intestines, we remark that the former are nearly straight, whereas the latter, as we have before remarked, are disposed in arches which anastomose freely one with another. The vis à tergo in the iliac, femoral, tibial, and peroneal arteries, undergoes the least possible diminution of power, being lessened neither by sudden changes in the course of the vessels, nor by large and frequent

inosculations, and the blood returned by the corresponding veins is greatly assisted in its ascent by muscular contractions, and its descent prevented by valves: but notwithstanding this disposition of the vessels of the lower extremities, *varicose veins* are of common occurrence, and among those persons chiefly whose occupations compel them to stand daily for many hours; and this condition of the veins is produced by the operation of two causes: first, the constantly opposing influence of gravitation upon the ascent of the venous current; and secondly, the non-agency of muscular contraction. If, then, without the assistance afforded by muscular contraction, the vis à tergo in the arteries of the lower extremities has a difficulty in propelling the blood through the corresponding veins after it has passed through a single capillary system, and that vis à tergo neither lessened by flexuosities nor anastomoses,—is it reasonable to suppose that the vis à tergo in the cæliac and mesenteric arteries, after suffering a great necessary diminution from the tortuosity and frequent inosculations of the numerous branches of those arteries, is a *sufficient* power to propel the blood, without the assistance of valves, without the agency of muscular contraction, and in direct opposition to the influence of gravitation, through *two* venous and *two* capillary systems?

We have observed that from the construction of the hepatic veins, they must always contain the same quantity of blood; but we cannot thence infer that the velocity of the blood's progress through those

veins is also unvarying; on the contrary, it is certain that it does vary, and for the following reason:—The blood in the hepatic veins is acted upon through the medium of the blood in the portal vein, and the latter is expressly adapted to contain much or little; now when there is but little blood in the trunk and branches of the portal vein, it cannot be so propelled as to have an equal effect in the propulsion of the never-varying quantity contained in the hepatic veins as when the former are distended; indeed, it is more than probable that a certain distension of the portal trunk and branches must be produced before the blood in the hepatic veins can be moved at all. We are then, I think, justified in drawing the following inference, that the velocity only with which the blood is propelled through the hepatic veins can vary, but in the portal vein, i. e. the portal trunk and branches, both the velocity and quantity:—this leads to the further inference, that a regulating as well as propelling power is required: for the due performance of so important a function there should be an organ; and there is; an organ to which the real function has not hitherto been ascribed, and that organ is the SPLEEN. It is the spleen which propels the portal blood through the portal trunk, branches, plexuses, and hepatic veins, to the inferior cava and auricle, and regulates the quantity and force with which it is propelled.

That such is the *function* of the spleen,—that it assists in the return of the venous blood,—and that it is therefore to be regarded as an ASSISTANT CIR-

CULATORY ORGAN, will be attempted to be proved in the course of the succeeding pages: it may be well, however, to premise, that the opinion is grounded upon a consideration of the following circumstances:—

1. That for the reasons already specified, the vis à tergo of the heart's action appears to be inadequate duly to propel the blood through two venous and two capillary systems, and that an additional power is therefore required for its propulsion through the second venous and capillary system — the portal trunk, branches, plexuses, and hepatic veins.
2. That the spleen, by its structure, properties, and position,—and by its connection with the trunk of the portal system by the splenic vein, is eminently adapted for the performance of such function.
3. Because there is another organ, the function of which is analogous, and the texture of which bears the closest possible resemblance to that of the spleen.
4. Because much more venous blood is returned to the heart by the hepatic veins than there is arterial blood supplied to the digestive organs by the cæliac and mesenteric arteries.
5. Because the spleen is relatively much larger in man than in the quadruped; a greater power being needed for the propulsion of

blood through a venous system, the direction of which is vertical, than through one the direction of which is horizontal.

That the vis à tergo of the heart's action is not adequate *per se* to propel the blood through two venous and two capillary systems, and that some additional power is necessarily required for its propulsion through the second venous and capillary system, has perhaps been sufficiently shewn in the preceding observations; we have next, therefore, to consider the situation, structure, and properties of the spleen; a brief and general description of which is, however, all that will be required for the purposes of this inquiry.

The spleen is situated in the posterior part of the left hypochondrium, between the great end of the stomach and the ninth, tenth, and eleventh ribs. It is completely invested by peritoneum, a duplicature of which proceeds from the stomach to the spleen, enclosing between its laminæ the splenic vessels. Under its peritoneal investment is a membranous and highly elastic capsule, from the inner surface of which numerous thread-like and also equally elastic prolongations proceed through the organ to its opposite side, and which by their frequent communications present a reticulated appearance. The spleen is composed entirely of vessels, and of these elastic prolongations from its capsule. It receives the splenic artery, the largest of the three divisions of the cæliac, and which divides into five or six branches before it penetrates the concave

surface of the organ: the ultimate divisions of these branches of the splenic artery are arranged in tufts, and terminate in the great venous plexus, of which the chief bulk of the organ is composed, and from which the splenic vein originates. The veins forming this plexus are remarkable for their large size, tenuity, and extensibility, and for their free communications with each other in every possible direction, by numerous large lateral orifices: hence the cellular, spongy appearance of the cut surface of an inflated spleen, and its resemblance in texture to the corpora cavernosa penis. This similarity, together with the following circumstances, namely, that in the living animal the spleen varies considerably in size at different times, and that it becomes greatly distended when the splenic vein is compressed or tied, and quickly returns to its former dimensions when the compression is remitted or the ligature removed, has given rise to the observation, that in "texture and phenomena the spleen bears a close resemblance to the erectile organs."—(Béclard.)

The splenic vein is nearly five times the size of the splenic artery, and is joined behind the pancreas by the great mesenteric vein, this junction forming the trunk of the vena portæ, the area of which is much less than the combined area of the two veins by which it is formed. The spleen is therefore connected by means of the splenic vein with the origin of the portal trunk; is placed at the very commencement of the second or additional venous system; is possessed of highly elastic and contractile

properties; has no excretory duct; and is in man an organ of about one-sixth of the weight of the liver, and in quadrupeds, only one-twelfth, one-fourteenth, or even one-sixteenth.

Magendie, Précis Elémentaire de Physiologie, tome 2, p. 408, makes the following observations :— "Sur les animaux vivants, les dimensions de plusieurs organes peuvent être augmentées à volonté. Prenez, par example, les trois dimensions de la rate d'un chien, puis, l'abdomen étant ouvert, injectez une pinte de sang d'un autre chien dans ses veines, vous verrez la rate grandir graduellement, et avoir acquis, à la fin de l'injection, un tiers ou une moitié en sus de ses dimensions premieres.—Faites l'expérience opposée : après avoir mesuré la grandeur de la rate d'un animal, saignez-le jusqu'à défaillance, et vous verrez la rate diminuer sensiblement de volume à mesure que le sang s'ecoulera. Des observations analogues peuvent être faites sur le foie, mais comme le tissu de cet organe est moins extensible que celui de la rate, les changements de volume sont moins marqués." * * * "Ce que vient d'être dit sur les dimensions de la rate, par rapport au volume du sang, est de nature à jeter quelque lumière sur *les fonctions* de ce singulier organe. D'après ce que nous avons dit, la rate est un véritable réservoir à parois élastiques, qui presse incessament sur le sang qu'il contient, et qui tend à le faire passer dans le système de la veine porte. Le peu d'épaisseur et d'elasticité des parois de cette veine, l'absence des valvules à son intérieur, doivent permettre facile-

ment au sang pressé par la rate d'y pénetrér. La rate doit d'autant plus facilement expulser le sang qu'elle contient, que non-seulement elle est très élastique, et tend ainsi physiquement à revenir sur elle-même, mais qu'en outre elle est douée d'une force contractile d'une genre particulier, et qui se met en évidence sous l'influence de certaines substances, la noix vomique, par exemple."

From the preceding quotation it appears that Magendie was of opinion, that the spleen, by its elasticity and peculiar contractile power, assists in propelling the blood along the trunk and branches of the portal vein; but he would not have confined himself to this single observation had he been aware of the importance of his opinion, and had he not supposed that this was merely a subordinate, and not its chief, use; indeed the expression "les fonctions" is sufficient to prove that he did not regard the spleen as an assistant circulatory organ, simply. The little importance which has been attached by others to this remark of Magendie's is shewn by the fact that it is passed over unnoticed in all the subsequent systematic treatises on physiology.

The resemblance of the spleen in "texture and phenomena to the erectile organs" is certainly remarkable; but it has a stronger and more important resemblance to another organ, namely, the Placenta, in structure, in properties, and also, as will be attempted to be proved, in function, and in disease, which it is singular should have hitherto escaped observation. Take a spleen in one hand, and

a small and contracted placenta* in the other, and the outward similarity between the two will not fail forcibly to strike the observer. The circumference of both is more or less lobulated, or fissured; the spleen is enveloped by an elastic capsule—the placenta is enclosed between the two layers of an elastic membrane, the decidua; both organs present a spongy and reticulated texture, consisting almost wholly of vessels, and chiefly of veins; "nervi lieni paucissimi sunt et minimi," observes Haller, and the same remark is applicable to the placenta, in which, however, the existence of nerves is usually denied;† both organs are possessed of a peculiar contractile power.

The similarity of the spleen and the placenta is most striking after they have undergone maceration, and their texture been unravelled; they then present a cellular and flocculent appearance, and so close is their resemblance to each other, that if it were not

* When only one ligature is placed upon the umbilical cord before dividing the latter (as recommended by Smellie and Dewees), the placenta becomes emptied of its contents almost completely, partly by its own contractility, and partly by the subsequent contractions of the uterus, and the consequent compression to which it is subjected in passing through the cervix and os uteri; it is then upon inspection only half, or even one-third, the size which it is when two ligatures are employed, and when consequently it is allowed to become gorged with blood, almost to rupture, previously to expulsion.

† "Sir E. Home and M. Bauer believed they had detected nerves in the placenta by the aid of a strong magnifying power; and this is also the opinion of Chaussier."— Ramsbotham's Obstetric Medicine, p. 91.

for some difference in size and shape it would be difficult to distinguish between them.*

Whether or not it be conceded that the spleen is the organ which subsequently to birth propels the blood through the portal plexuses and the hepatic veins to the inferior cava and right auricle, regulating its quantity, and also the force with which it is propelled, I presume there are none who will be disposed to deny that the placenta performs that function in the fœtus: and as before birth the umbilical vein conveys the blood in which is contained the *materiel* for the nutrition and growth of the fœtus, which blood is propelled by the placenta through the capillaries of the fœtal liver to the right auricle, so subsequently to birth the portal vein conveys the blood returning from the digestive tube diluted with the fluids taken up by venous absorption, and which is propelled through the portal plexuses and hepatic veins to the auricle by the spleen. To add another argument, therefore, to those which have already been adduced in support of the opinion that the vis à tergo is inadequate to propel the blood through two venous and two capillary systems, and that some additional power is necessarily required for its propulsion through the second system of venous and capillary vessels, it may be observed, *that much more venous blood is returned to the heart by the hepatic veins, than there is arterial blood sup-*

* There are two preparations of this kind in the Museum of St. Bartholomew's Hospital, which display the remarkable similarity of texture of these two organs.

plied to the digestive organs by the cæliac and mesenteric arteries. If, therefore, the spleen be *not* an assistant circulatory organ, the vis à tergo, per the cæliac and mesenteric arteries, propels, not merely the blood which those arteries receive, through a single capillary and venous system, but also (notwithstanding the many disadvantages which have been already pointed out) propels with, and in addition to, that blood, *all the fluid which enters the digestive tube by food or drink through the second system of venous and capillary vessels;* i. e. through the portal trunk, branches, plexuses, and hepatic veins, to the inferior cava and auricle.

The ultimate divisions of the umbilical arteries terminate in the fœtal portion of the placenta in the venous plexus forming the umbilical vein, in like manner as the ultimate divisions of the splenic artery terminate in the venous plexus which forms the splenic vein; but in neither instance does the vis à tergo by these arteries afford any assistance in the propulsion of the blood through their corresponding veins. That the placenta, at least, is alone adequate to effect this propulsion is proved by the circumstance of acephalous and other fœtal monsters being commonly acardiac.

Before birth the liver is large—very large in comparison with other organs, and the spleen is small, and its artery smaller than the hepatic; after birth the splenic artery becomes larger than the hepatic: if we bear in mind the inverted position of the fœtus in utero, and also the two terminations of the umbi-

lical vein, we shall have no difficulty in understanding why the fœtal spleen is so small; its function of propelling the portal blood through the capillaries of the liver only commences after birth, that function before birth being performed by the placenta.

Having remarked the similarity in the external appearance and internal organization of the spleen and the placenta; that the latter and the umbilical vein perform previously to birth the function of the former and the portal vein; and that the spleen, and therefore the placenta, in texture and phenomena bear a remarkable resemblance to the erectile organs, the most important of which is the penis; and having moreover observed that the spleen and the placenta, in addition to their elasticity, possess a peculiar contractile power, by which power both are enabled to propel the blood through the capillaries of the liver and the hepatic veins to the right auricle; we are now prepared to expect that this *contractility* alike possessed by each of these organs, the penis, spleen, and placenta, will be excited by the same agencies, whether of a moral or physical nature.

Fear, or fright, it has already been observed, is regarded as by far the most frequent exciting cause of epilepsy; and it is also a very powerful agent in exciting the contractility of these organs. No physiological remarks, it is presumed, will be needed to prove its influence upon the contractility of the penis; some observations are, however, required to

shew that it is capable of exerting a similar influence upon the contractility both of the spleen and the placenta.

Fear is the most common exciting cause of abortion as well as of epilepsy; and it may here be remarked, that the exciting causes of these two diseases, or, as they ought rather to be considered, *medical accidents*, are, in general, the same. When abortion is induced by fright, or from the administration of ergot (the former the most frequent, and the latter one of the most powerful of its exciting causes), it is supposed in either case to be the effect of some direct or specific influence upon the uterus. It is probable, however, that neither exerts any direct or specific influence upon this organ, but upon the placenta; that their effect is to excite the contractility of the latter, and that it is contraction of the placenta, either natural or induced by artificial means, which, whether in abortion, premature labour, or parturition at the full period, invariably gives rise to, and is the appropriate stimulus of, uterine contraction.

The heart, to which organ the uterus bears a considerable resemblance in the kind of its muscular texture, is excited to contract by an internal and appropriate stimulus, a moving and vital fluid; and therefore the uterus, which like the heart is a hollow muscle, is probably also excited by an appropriate, internal, moving, and vital stimulus, a contracting placenta—the duration, frequency, and power of the uterine contractions being respondent to, and go-

verned by those of the placenta, and are therefore intermittent, or remittent, weak, or powerful.

That fear exerts a depressing influence upon the heart, it is impossible to doubt; can we then admit that the same moral agency which in a measure paralyzes the heart, acts as a direct stimulus to the uterus? Deglutition, the peristaltic motion of the digestive tube, expulsion of the urine, fæces, &c., are all excited by *internal* stimuli. The argument, however, hardly needs the support of analogy, inasmuch as we have positive proof that the most certain and speedy means of exciting contractions of the uterus, is the introduction of an internal and moving stimulus into its cavity. "When the uterus (says Dr. Ramsbotham, see Principles of Obstetric Medicine) is in an uncontracted state after withdrawal of the placenta, the patient is subject to a continuance of the uterine hæmorrhage; but it generally happens that the stimulus of the hand excites uterine contraction, and that the hand and the placenta are expelled together. Should this however not occur (he adds p. 520), we may keep the hand a short space of time within the uterine cavity, and endeavour to ensure contraction by quietly *moving* our fingers, so as to irritate the parietes in some trifling degree." The same author also states that this seldom fails to induce efficient contraction of the uterus.

As it is therefore evident that the most certain and effective method of inducing uterine contraction artificially, is by internal stimulation; as the con-

tractions of the heart, pharynx, œsophagus, &c., are excited by appropriate internal, and indeed moving stimuli,—it would be an extraordinary deduction to conclude that the uterus is an exception to what appears to be a general rule, and that it is not the placenta which excites its contraction. In the ninth volume of the Medico-chirurgical Transactions, a case is recorded in which expulsion of a blighted fœtus, and placenta, occurred at the seventh month of pregnancy, a living child still remaining up to the full period. The fœtus was about the size of a fœtus at the third month; the placenta was perfectly healthy, and natural in appearance, and of the size it usually presents at the seventh month. Now what are we to believe was the stimulus which excited uterine contraction in this case, if it was not a contracting placenta? If it (the uterine contraction) were induced by the mere presence of a dead fœtus, and of a non-contracting, though still living, placenta, why did not their expulsion take place sooner? If the uterus, unsolicited by the placenta in question, took upon itself to contract, why did it cease its action after the separation and expulsion of a part only of its contents, and retain the remainder up to the full period of gestation? and, again, if separation of the placenta be the effect entirely of uterine contraction, and the placenta itself affords no assistance in that separation, how happened it that in this instance the uterine contractions which were adequate to effect the separation of one placenta, did not produce that of both? It is not improbable

that the placenta was here the chief agent in effecting its own separation; but be that as it may, that the placenta is capable of contraction, and of powerful contraction too, is still further indicated by the fact, that the first symptom of abortion is not pain from uterine action, but more or less hæmorrhage from a partial separation of the placenta; which partial separation and consequent hæmorrhage must therefore be attributed to contraction of the placenta itself, and more especially of its maternal portion (which probably possesses more nerves and a greater contractile power than the fœtal portion of the organ); whereas the uterine contractions, by which the separation is completed, and expulsion effected, are only secondary, and excited by its (the placenta's) own previous contractions.

If we admit placental contraction to be the natural and appropriate stimulus of uterine contraction, then we must also admit, that when abortion is induced by fright, ergot, or any other known exciting cause, it is owing to such cause exciting the contractility of the placenta. The influence of fear upon the contractility of the spleen, and the instinctive actions to which that influence gives rise, will occupy our attention at a future stage of the inquiry. That ergot acts upon the contractility of this organ has been observed by Mr. S. Wright, who, in an essay on the physiological action of that substance, published in the Edin. Med. and Surg. Journal, Nos. 141-2, remarks, that when dogs have had small doses of ergot administered to them daily for several

weeks, the spleen is so much reduced in size, that upon examination after death, it is with difficulty found and recognized. There is therefore but little reason to doubt that both fear and ergot exert a precisely similar influence upon the spleen and the placenta, which, considering the close analogy between these two organs in structure, properties, and function, we might *à priori* have been led to expect.

There are, however, several other agents besides fear and ergot which have the power of exciting the contractility of the spleen. The remark was first made by Defermon in the Nouvelle Bibliothèque Medicale for 1828, and has been repeated by Magendie and others, that strychnia, camphor, and muriate of morphia, cause the spleen to contract; and I have observed that hydrocyanic acid has the same effect upon this organ, and in an equally remarkable manner as strychnia.* Whether these poisons exert any similar influence upon the contractility of the placenta, we are at present ignorant; it is, however, probable that their action upon both organs is essentially the same.

It is not a little singular that every one of the above-named and seemingly heterogeneous agents, namely, (1) strychnia, (2) camphor, (3) muriate of

* The spleens of dogs which have been destroyed by any of these poisons, present a striking contrast when compared with the spleens of other dogs which have not perished by the same means. In the former they are contracted to the utmost, and are consequently much smaller and harder than in the ordinary or natural state.

morphia, (4) ergot of rye, and (5) hydrocyanic acid, produces paroxysms of insensibility and convulsions, closely resembling those of epilepsy. Camphor and ergot, it is said, are capable of inducing epilepsy; the paroxysms resulting from nux vomica (strychnia) have been mistaken for those of epilepsy; and the pathological state produced by hydrocyanic acid is believed to be identical with that which gives rise to epilepsy.

The following cases of poisoning by some of these agents, and observations upon the physiological action of others, are introduced to shew the similarity between the effects which each of them produces, and the symptoms of an epileptic paroxysm. What the pathological condition is which gives rise to those effects; whether it be cerebro-spinal congestion consequent upon prevented ingress into the auricle; and whether it be the same as, or different from, the proximate cause of epilepsy, will be subsequently considered.

1. Strychnia. In the London Medical Repository for 1823, p. 448, a case of fatal poisoning by nux vomica is detailed by Mr. Ollier, Surgeon to the Western Dispensary, of which the following is an abridgement:—A young married woman having quarrelled with her husband, took as nearly as could be ascertained about two drachms and a half of nux vomica in water. Forty minutes elapsed before any particular symptoms were produced; she was perfectly sensible and without pain, but seemed in alarm, and entreated her husband not to leave her

(the previous day he had threatened to abandon her); she then threw herself back in the chair, her legs being extended and considerably separated; her pulse was faint and quick, and she called frequently for drink. Two drachms of pulv: Ipecac. were mixed in a tea-cupful of warm water, and a fourth part administered every five minutes; of which three doses were taken, the last with great difficulty: she had also warm water at intervals. Before taking the first dose she had a slight and transient convulsion; great trepidation succeeded, and in a few minutes she had another and more violent attack, and shortly afterwards a third. The duration of these fits was from a minute and a half to two minutes: the pulse and respiration were imperceptible during the paroxysms. Her whole body was straightened and stiffened, and her legs pushed out and forced wide apart; the face and hands were livid; the muscles of the former, especially of the lips, were violently agitated, and she made constantly a moaning, chattering noise. She was not unlike one in an epileptic fit, but that she did not struggle, though, as she was forced straight out, it became difficult to keep her from falling on the floor. During the short intervals of the attacks she was quite sensible; her pulse was quick and faint; she was thirsty, perspired, and made many attempts to vomit. A fourth and most violent attack soon followed, in which the whole body was extended to the utmost, and she was rigidly stiff from head to foot; she then fell into a state of asphyxia, from

which she never recovered, for she never breathed again. She relaxed her grasp; her discoloured hands dropped upon her knees, and her face too was livid; the brows were contracted; the lips wide apart, shewing the whole of the closed teeth, and a salivary foam issued plentifully from the corners of her mouth. The expression of her countenance was at this moment very frightful. In lifting her up to lay her on the bed it was discovered that the urine had been discharged. All this took place in little more than half an hour after Mr. Ollier first saw her. About five hours afterwards she was still straight and stiff, and on the following day the head and trunk were opened; the joints had then become as pliable as before they were unyielding. The vessels of the pia mater were turgid with blood, and there was an ounce of fluid in the ventricles: there was also a small quantity of bloody fluid in the cavity of each pleura. The heart was pale, flaccid, and empty; and in the stomach about a pint of brownish fluid was found. There was also a slight but extensive redness of the internal coat,—the surface probably to which the poison had been applied.

A remarkable occurrence, shewing the power of nux vomica in producing paroxysms of insensibility and convulsions not distinguishable from epilepsy, took place at the Lock Hospital, in the year 1835. The then house-surgeon, Mr. Chappell, was sent for to no less than six in-patients, all males, who were seized, within the space of a few hours, with what at the time were considered as genuine epileptic fits.

One of them had two seizures; the rest only one each, and fortunately none of them were fatal: one man, however, bit his tongue very severely. So many cases occurring in such rapid succession could not fail to excite surprise, and inquiry as to the cause of their production. It shortly transpired that all these persons had gonorrhœa, and for which they were taking cubebs. Suspicion naturally fell upon the medicine; and upon inquiry being made at the shop of the herbalist, from whence a supply of the cubebs had been recently procured, it was ascertained to have been ground in a mill in which nux vomica had been ground previously, and that from the carelessness of an assistant the mill had not been properly cleaned. No doubt therefore remained, that a portion of the nux vomica had become mixed with the cubebs, and had given rise to this singular, and fortunately not tragical occurrence.

2. Camphor. The following remarks are extracted from Dr. Pereira's Elements of Materia Medica and Therapeutics :—" Camphor specifically affects the nervous system. Regarding the symptoms of this effect but little difference of opinion prevails. In large doses it causes disorder of the mental faculties, the external senses, and volition; the symptoms being lassitude, giddiness, confusion of ideas, disordered vision, noise in the ears, drowsiness, delirium or stupor, and convulsions. These phenomena, which have been observed in several cases, agree with those noticed in experiments on

brutes.* In its power of causing stupor, camphor agrees with opium, but it differs from the latter in its more frequently causing delirium and convulsions. *Epilepsy has been ascribed to the use of camphor.* In excessive doses it acts as a powerful poison. The best related case is that of M. Alexandre (Exper. Essays, p. 128, 1768), who swallowed two scruples in syrup of roses. In about twenty minutes he experienced lassitude and depression of spirits, with frequent yawnings; at the end of three-quarters of an hour his pulse had fallen from 77 to 67. Soon after he felt giddy, confused, and almost incapable of walking across the room. He became gradually insensible, and in this condition was attacked with violent convulsions and maniacal delirium. From this state he awoke as from a profound sleep; his pulse was 100, and he was able to reply to interrogatories, though he had not completely recovered his recollection. Warm water being administered, he vomited up the greater part of the camphor, which had been swallowed three hours previously; and from this time he gradually recovered."

3. Morphia. "Physiological action of morphia. —When the dose is increased the effects become somewhat alarming. Great cerebral excitement is produced, vision is disordered and obscured, there is singing in the ears, and the patient, *when lying*

* "Three drachms of camphor dissolved in oil and given to a dog, the œsophagus being tied, caused violent convulsions, somewhat analogous to those of epilepsy, followed by insensibility and death."—Ibid. p. 792.

horizontally, experiences sudden convulsive movements, like those produced by the electric shock. When a fatal dose has been swallowed, the stomach sometimes manifests irritation, but this is soon followed by great disorder of the cerebro-spinal system, which ultimately assumes an apoplectic character. The sight becomes dim, excessive weakness is experienced, gradually all consciousness is lost, and coma supervenes, attended usually with contracted though sometimes with dilated pupils, coldness of the surface, frequent and small pulse, hurried stertorous respiration, and *occasionally with convulsions*. Not unfrequently lividity of the skin is observed."—Ibid. vol. 2, p. 1317.

4. Ergot of Rye. In the first part of Mr. Wright's Essay on the physiological action of this substance are some remarks on Spasmodic Ergotism, a disease which has very rarely occurred in this country, but which at different times has devastated whole districts on the continent of Europe. In this disease, which is induced by eating bread containing ergotted grain, but more especially rye, we are informed that the chief symptoms are *convulsions alternating with lethargy*. The following passage is from the first part of Mr. Wright's Essay, published in No. 141 of the Edin. Med. and Surg. Journal:—

"In 1722 Silesia, in 1723 the environs of Berlin, and in 1736 Wurtemberg, in Bohemia, sustained the disastrous effects of ergotism. The symptoms of the first epidemic have been ably described by M. Vater, and those of the latter with equal pre-

cision by J. A. Scrinc, who alone saw five hundred individuals the subjects of its virulence. He describes the disease as commencing with a disagreeable sensation in the feet—a tingling or itching; a violent cardialgia then came on, and the disease ascended to the hands and the head. The pains in a short time subsided, the head became heavy, and vertigo prevailed, the eyes appearing to have a thick mist before them. The patient then complained of extreme heat, which was attended with diaphoresis. The fingers and hands were so spasmodically contracted that no ordinary force could straighten them, and the pain was described as equalling that of luxation. Some of the patients became totally blind, and others had double vision. The memory also failed, the conversation was wild and unintelligible, and the movements staggering and awkward. Some became maniacal, some melancholic, and others comatose. The disease was usually accompanied with opisthotonos, and an abundance of saliva tinged with blood, or coloured greenish-yellow, poured from the mouth. The tongue was frequently so much swollen as to impede articulation. The greater part of those who had *epileptic fits* died, and such as experienced sensations of coldness and rigidity in the limbs consequent upon the subsidence of the itching, had less distension of the hands and feet."

The preceding description of the symptoms of spasmodic ergotism shews that the cerebro-spinal system is more especially subject to the ergotic in-

fluence, and from the last sentence it appears that even "epileptic fits" are very frequent consequences of that influence. But we have still more striking evidence of the power which ergot possesses of producing, I will not say epilepsy, but paroxysms of insensibility and convulsions; and in which paroxysms there are also, as in epilepsy, lividity and turgescence of the face and hands. In No. 151 of the Edin. Med. and Surg. Journal is contained a paper by Dr. Catlett, pointing out some of the injurious effects of this substance when employed in obstetric practice; and among others three cases of *puerperal convulsion* are recorded which were obviously induced by its administration. It is unnecessary to quote these cases: that they were, however, fairly attributable to the deleterious agency of ergot is shewn by the following passage, which I therefore extract:—"In aiding the determination as to how far ergot was truly efficient in the convulsions of these three females, it may not be out of place to hint that seven-eighths of the cases of idiopathic convulsion are considered as occurring in first deliveries, or as taking place in those more especially who have been the subjects of them in their preceding labours, or in cases of twins, and when the uterus is greatly distended from an unusual quantity of the liquor amnii. None of these concomitants were present in any of the three cases that are now cited."

But the deleterious agency of ergot is not limited to the mother, for it has also the power of inducing similar consequences in her offspring. "It has

happened to me" (says Dr. Ramsbotham, op. cit. p. 638), "in four different cases to witness the death of the fœtus a few hours after birth by *convulsions*, postquam partus prematurus inductus fuerat ope solum secalis cornuti. Three of these cases occurred in the children of the same woman, and in all four the medicine had been administered for four or five days in full doses."

5. Hydrocyanic Acid. The following remarks are extracted from Dr. Pereira's Elements of Materia Medica and Therapeutics. "Post mortem appearances of poisoning by hydrocyanic acid.—The venous system is usually gorged with blood, while the arteries are empty: the blood is in many cases fluid, dark, or bluish black, and viscid or oily: *the vessels of the brain and spinal marrow are frequently gorged with blood;* and the cerebral ventricles sometimes contain a serous or sanguineous liquor; the lungs are, in some instances, natural—in others turgid with blood:* the internal lining of the stomach is sometimes red."—P. 244.

Organs affected.—"The parts specifically affected by this acid are the brain and true spinal system. The pain in the head, the insensibility, and the coma, are evidence of the cerebral affection; while the tetanic convulsions depend on the disorder of

* If the body be opened *immediately* after death, the lungs will be found to contain very little blood; but if a certain time be allowed to elapse, the blood escapes from the right cavities of the heart into the lungs; and which then consequently become more or less turgid.—J. J.

the true spinal system. Marx (*die Lehre von d. Giften*, 1er. Bd. 2e. Abt. S. 154) mentions the following experiment performed by Wedemeyer (*Versuche über das Nervensystem*, S. 241, Vers. 7), and which shews the independent action of the acid on the spinal marrow. The spinal cord of a dog was divided between the last dorsal and first lumbar vertebræ, so that the hind legs were completely paralyzed and insensible to mechanical irritants; hydrocyanic acid was then introduced into one of the hind legs; in one minute, symptoms of poisoning commenced, the hind as well as the fore legs were convulsed, and in twelve minutes the animal was dead. The affection of the respiratory and circulatory organs produced by hydrocyanic acid is probably only secondary; that is, is the result of the influence of this agent over those parts of the nervous system from which the respiratory organs and heart derive their nervous power. The insensibility caused by hydrocyanic acid occurs too rapidly, in many cases, to be the result of asphyxia caused by paralysis of the muscles of respiration."

"Condition of the brain and spinal marrow.—The precise pathological condition of the brain and spinal cord of an animal under the influence of hydrocyanic acid cannot be positively determined, and is, therefore, a matter of conjecture. *Whatever it may be, it is probably identical with that which occurs during an epileptic paroxysm, and with that produced by loss of blood*, for the essential symptoms (insensibility and convulsions occurring suddenly) are the

same in all three states, and ammonia has been found to relieve them (see p. 171). Dr. Hall (Lectures on the Nervous System, p. 139) has shewn that the convulsion from hæmorrhage is spinal. Dr. Holst, Professor of Materia Medica in the University of Christiana, in Norway, told me of a case of epilepsy under his care, in which it was observed that the pulse in one arm was always imperceptible during the paroxysm. On a post mortem examination it was discovered that an anomalous distribution of the arteries existed, so that this arm was supplied with blood which had circulated through the brain; hence it would appear, that during the epileptic paroxysm the cerebral circulation was impeded: does this happen in poisoning by hydrocyanic acid?"*

The preceding observations shew that all the poisons in question (and there are some others,) have the power of inducing paroxysms of insensibility and convulsions very similar to epilepsy; and the opinion generally entertained is, that poisons which act upon the cerebro-spinal system, affect that system by a peculiar 'irritation' which they produce on the nerves of the part to which they are directly applied, and which irritation is in some incomprehensible manner conveyed or 'reflected' by the nerves to the ner-

* There must be some inaccuracy in the above statement of Dr. Holst, as to the anomalous distribution of vessels; for how could "the arm be supplied with blood which had circulated through the brain"? Nevertheless, the surmise which Dr. Pereira throws out, reasoning from this supposed fact, is, I believe, an approximation to the truth, as will subsequently appear.

vous centres. But the recent experiments of Mr. Blake prove that this opinion is no longer tenable; and that it is not through the medium of the *nerves*, but the *circulation*, that poisons affect the cerebro-spinal system. The following account of one of Mr. Blake's experiments is extracted from No. 142, p. 45, of the Edin. Med. and Surg. Journal:—

"The abdomen of a dog was laid open; a ligature was passed under the vessels entering the liver, and tied. Three drachms of hydrocyanic acid of Scheele's strength, containing 3·3 per cent. of acid, were introduced into the stomach through an opening made into the parietes. The poison was thus brought into contact with a large surface freely supplied with nerves, at least with those nerves on which poisons are supposed more particularly to produce their impressions. (See Addison and Morgan on Poisons, p. 35.) Under these circumstances, the poison remained in the stomach ten minutes without producing the slightest general effect. The ligature on the vena portæ was then removed, so as to restore the circulation over the viscera. One minute after the removal of the ligature the animal began to experience the effects of the poison. The ligature was again replaced; but before this could be effected, a sufficient quantity of the poison had been absorbed to arrest the respiratory movements, and the animal must have speedily died, had not artificial respiration been had recourse to. After this had been continued eight minutes, the animal had sufficiently recovered to continue the respiratory movements

itself. After a short interval, the ligature from the vena portæ was again removed: the animal was dead in two minutes.—This experiment (Mr. Blake observes) affords a strong proof of the non-action of poisons when merely applied to the extremities of the nerves, for not only did the poison produce no effect before it entered the circulation, but we find the animal recovering from the effects of the poison with three drachms of hydrocyanic acid in its stomach."

In a subsequent contribution to the same Journal (No. 149, p. 417), Mr. Blake says, "It is evident that should the action" (of a poison which affects chiefly the nervous system) "be due to an impression produced on the nerves of the part to which it is directly applied, no appreciable interval should elapse between its application and the appearance of symptoms of its action. *If, on the contrary, a poison affecting the nervous system, only acts when applied directly to the nervous centres,* it is equally evident, that no symptoms of its action should manifest themselves until at least sixteen seconds after its application, this being the shortest period in which blood with which it has been mixed (supposing the poison has been injected into the jugular vein) can be brought into *contact* with any of the nervous centres. The substance I made use of was *strychnia*, as I have found it to act more rapidly than any other poison, not excepting woorara and conia."

Mr. Blake has, beyond question, succeeded in overthrowing the opinion of those physiologists who

suppose that the effects of poisons which "act upon the nervous system are due to an impression produced on the nerves of the part to which they are directly applied;" and the opinion which he endeavours to establish in its stead is, that such poisons only produce their effects when they come into *actual contact* with the nervous centres; or, in other words, that the insensibility and tetanic convulsions produced by strychnia (the substance usually employed by him in his experiments) are attributable to the brain and spinal cord being supplied with a poisoned fluid instead of healthy blood. Now this opinion of Mr. Blake's is, I conceive, not less unsatisfactory than its dethroned predecessor; for it does not explain how the insensibility and convulsions are produced, nor why the respiration becomes arrested, nor what is the cause of the turgescence and lividity of the face and hands: but a further, and indeed fatal, objection to it is, that precisely the same group of symptoms occurs in epilepsy, when no poison has been administered. In both cases, however, outward evidence of the existence of cerebro-spinal congestion is afforded us by the lividity and turgescence of the face and hands; and which congestion, we have already seen, is alone adequate to the production of insensibility and convulsions.

When a dog is destroyed by strychnia, hydrocyanic acid, or probably by any other poison which kills by producing insensibility and tetanic convulsions (of which latter the arrested respiration is only a part), and is examined immediately after death, we

have then inward evidence afforded us of the existence of cerebro-spinal congestion, by the right cavities of the heart and the venæ cavæ (and, consequently, the jugular and vertebral veins, and cerebral sinuses—the vena azygos, intercostal veins, and vertebral sinuses) being found enormously distended; whereas the lungs are exsanguine and contracted; and although the left cavities of the heart may contain either a small or considerable quantity of blood, the large arteries are always comparatively empty.

But these post mortem appearances do more than merely prove the existence of cerebro-spinal congestion. They not only reveal the effect, or pathological condition, or proximate cause (which I maintain cerebro-spinal congestion to be) of the two essential symptoms, namely, insensibility and convulsions, but also the *way* in which that effect, or pathological state, or proximate cause, is produced. The proper stimulus to the right cavities of the heart is venous blood; but if that blood be impregnated with certain poisons, its vitality or stimulating property is destroyed—it is rendered incapable of exciting the efficient contraction of those cavities, and therefore is not propelled by the right ventricle through the lungs (*hence their exsanguine appearance when examined immediately after death*); both auricle and ventricle consequently become excessively distended, the further ingress of blood is denied, its return from the brain and spinal cord is prevented, and cerebro-spinal congestion is produced.

Dr. Pereira (see last quotation from) very justly remarks, that whatever the precise pathological condition of the brain and spinal cord of an animal under the influence of hydrocyanic acid may be, it is probably identical with that which occurs in epilepsy, and with that produced by loss of blood; for the essential symptoms (insensibility and convulsions occurring suddenly) are the same in all three states: and subsequently he observes, reasoning from the supposed fact communicated to him by Dr. Holst, "hence it would appear that during the epileptic paroxysm the cerebral circulation was impeded: does this happen in poisoning by hydrocyanic acid?" and, he might have added, *in articulo mortis* from hæmorrhage. Instead of the *cerebral* circulation being simply *impeded* in the paroxysm consequent on poisoning by hydrocyanic acid—in the epileptic paroxysm—and also in the death-struggle from loss of blood, the *cerebro-spinal* circulation is *arrested;* and to which state of arrest or stagnation is superadded that of congestion, more or less excessive. That cerebro-spinal congestion exists in the paroxysm consequent on poisoning by hydrocyanic acid, and in the epileptic paroxysm, has been already shewn; and there is also, if not positive evidence, every reason to believe, and none to doubt, that it is also produced by excessive loss of blood. That *cerebral* congestion, at least, is so produced, we well know; for, "in animals which have been bled to death" (observes Dr. Abercrombie),* "when all the

* Treatise on the Pathology of the Brain and Spinal Cord, 2nd

other organs of the body have been found completely blanched and drained of blood, the brain has in general presented in this respect its usual appearance; and in some cases, the superficial cerebral veins have even been found in so distended a state, that one writer has proposed the paradox, that animals which have been bled to death die of apoplexy." * Convulsions, however, are not symptomatic of apoplexy, but of epilepsy: and although cerebral congestion only has been observed, that is no proof of the absence of spinal congestion; on the contrary, it materially strengthens the probability of its existence—nay, renders it almost certain; for as the brain and spinal cord are very similarly circumstanced, both as regards their envelopes and vessels, we can hardly conceive it possible that fatal hæmorrhage should produce cerebral congestion, and not at the same time produce spinal congestion in a corresponding ratio; and, as the experiments of tying the superior cava alone, and conjointly with the vena azygos, prove insensibility to be the immediate con-

Edition, p. 301.—" Conjectures in regard to the circulation in the Brain."

* We ought not to infer from this quotation that the pathological condition of the brain produced by fatal hæmorrhage is not always the same, or that cerebral congestion is only its occasional and not invariable consequence. It is manifest, that there is nothing to prevent the venous distension which exists just before death from diminishing after death; and therefore, if a considerable time be allowed to elapse before the dissection is made, and no great venous distension is found, that ought not to be regarded either as proof or indication that such distension has never existed.—J. J.

sequence of cerebral, and convulsions of spinal congestion; and, as insensibility and convulsions are the symptoms produced by fatal hæmorrhage, it is little less than certain that they are the effects of the same proximate cause which gives rise to them in poisoning by hydrocyanic acid, and in the epileptic paroxysm, namely, cerebro-spinal congestion.

The way in which cerebro-spinal congestion is produced by hydrocyanic acid is sufficiently manifest, and has been already pointed out; but the mode of its production by loss of blood is not very apparent. It certainly cannot be owing to the right cavities refusing to propel through the lungs the blood which is returned to them. Stagnation of the circulation through the head and spine (the proximate cause, probably, of the insensibility and muscular relaxation attendant on syncope) no doubt precedes the congestion; the latter being, as the convulsions indicate, nearly the last effect consequent on the loss of blood.

We have now to endeavour to ascertain in what way the cerebro-spinal congestion is produced which gives rise to the insensibility and convulsions of epilepsy. It was formerly observed, that if the quantity of blood supplied to the right auricle, and the force with which it enters it by the inferior auricular opening, were suddenly and temporarily augmented by a force greater than that with which the blood descends into that cavity from the superior cava (and which sudden and temporary augmentation could only be the effect of an inordinate rush of blood from the hepatic veins), the right cavities,

and which time and perseverance can finally perfect, if the allowance of these indispensable requisites be not dealt out with a too niggard hand.

THE END.

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